

Amendment under 37 C.F.R. § 1.111
Reply to Office Action of July 22, 2009

IN THE CLAIMS

Please amend the claims as follows:

Claim 1 (Previously Presented): A spin-tunnel transistor, comprising:
an emitter;
a collector formed adjacent to the emitter;
a base formed between the emitter and the collector and having a magnetization pinned layer of ferromagnetic material, a magnetization free layer of ferromagnetic material and a nonmagnetic layer between the magnetization pinned layer of ferromagnetic material and the magnetization free layer of ferromagnetic material, the magnetization pinned layer having a magnetization substantially fixed in an applied magnetic field, the magnetization free layer having a magnetization substantially free to rotate under the applied magnetic field, and the nonmagnetic layer being configured to decouple exchange coupling between the magnetization free layer of ferromagnetic material and the magnetization pinned layer of ferromagnetic material, the base including an electrode configured to apply a voltage between the emitter and the base; and
a tunnel barrier layer of antiferromagnetic material formed between the magnetization pinned layer of ferromagnetic material and the emitter or between the collector and the magnetization pinned layer of ferromagnetic material and provided with an exchange coupling with an adjoining one of the magnetization pinned layer of ferromagnetic material, the tunnel barrier layer being dielectric and tunnel conductive, and the magnetization of the magnetization pinned layer of ferromagnetic material being fixed by the exchange coupling between the magnetization pinned layer of ferromagnetic

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material and the tunnel barrier of anti ferromagnetic material.

Claim 2 (Original): A spin-tunnel transistor of claim 1, wherein the antiferromagnetic material is cobalt oxide, iron oxide or nickel oxide.

Claim 3 (Original): A spin-tunnel transistor of claim 1, further comprising a dielectric layer of nonmagnetic material formed in contact with the tunnel barrier layer of antiferromagnetic material.

Claim 4 (Previously Presented): A spin-tunnel transistor of claim 1, wherein the magnetization pinned layer includes a metal selected from the group consisting of Fe, Co, Ni, or an alloy containing the metal, and the tunnel barrier layer of antiferromagnetic material contains an oxide of the metal.

Claim 5 (Previously Presented): A spin-tunnel transistor of claim 1, wherein the tunnel barrier layer of antiferromagnetic material is formed between the magnetization pinned layer and the emitter, and the emitter includes a semiconductor surface contacting the tunnel barrier layer of antiferromagnetic material.

Claim 6 (Original): A spin-tunnel transistor of claim 1, further comprising another tunnel barrier layer of nonmagnetic dielectric material formed in contact with the magnetization free layer of ferromagnetic material.

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Claim 7 (Previously Presented): A magnetic reproducing head, comprising:
a spin-tunnel transistor comprising:
an emitter;
a collector formed adjacent to the emitter;
a base formed between the emitter and the collector and having a magnetization pinned layer of ferromagnetic material, a magnetization free layer of ferromagnetic material and a nonmagnetic layer between the magnetization pinned layer of ferromagnetic material and the magnetization free layer of ferromagnetic material, the magnetization pinned layer having a magnetization substantially fixed in an applied magnetic field, and the magnetization free layer having a magnetization substantially free to rotate under the applied magnetic field, the base including an electrode configured to apply a voltage between the emitter and the base; and
a tunnel barrier layer of antiferromagnetic material formed between the magnetization pinned layer of ferromagnetic material and the emitter or between the collector and the magnetization pinned layer of ferromagnetic material and provided with an exchange coupling with an adjoining one of the magnetization pinned layer of ferromagnetic material, the tunnel barrier layer being dielectric and tunnel conductive, and the magnetization of the magnetization pinned layer of ferromagnetic material being fixed by the exchange coupling between the magnetization pinned layer of ferromagnetic material and the tunnel barrier of antiferromagnetic material.

Claim 8 (Original): A magnetic reproducing head of claim 7, wherein the collector is electrically coupled with an electrical field effect transistor, and the spin-tunnel transistor and the electrical field effect transistor are formed on a same substrate.

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Claim 9 (Cancelled).

Claim 10 (Previously Presented): A magnetic reproducing head, comprising:
a spin-tunnel transistor comprising:
an emitter;
a collector formed adjacent to the emitter;
a base formed between the emitter and the collector and having a magnetization pinned layer of ferromagnetic material, a magnetization free layer of ferromagnetic material and a nonmagnetic layer between the magnetization pinned layer of ferromagnetic material and the magnetization free layer of ferromagnetic material, the magnetization pinned layer having a magnetization substantially fixed in an applied magnetic field, the magnetization free layer having a magnetization substantially free to rotate under the applied magnetic field; and, the nonmagnetic layer being configured to decouple exchange coupling between the magnetization free layer of ferromagnetic material and the magnetization pinned layer of ferromagnetic material, the base including an electrode configured to apply a voltage between the emitter and the base; and
a tunnel barrier layer of antiferromagnetic material formed between the magnetization pinned layer of ferromagnetic material and the emitter or between the collector and the magnetization pinned layer of ferromagnetic material and provided with an exchange coupling with an adjoining one of the magnetization pinned layer of ferromagnetic material, the tunnel barrier layer being dielectric and tunnel conductive, and the magnetization of the magnetization pinned layer of ferromagnetic material being fixed by the exchange coupling between the magnetization pinned layer of ferromagnetic

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material and the tunnel barrier of antiferromagnetic material.

Claim 11 (Previously Presented): The magnetic reproducing head of claim 10, wherein the collector is electrically coupled with an electrical field effect transistor, and the spin-tunnel transistor and the electrical field effect transistor are formed on a same substrate.

Claim 12 (Cancelled).